REMARKS/ARGUMENTS

Reconsideration of this application is respectfully requested.

The rejection of claims 1-14 under 35 U.S.C. §103 as allegedly being made "obvious" based on Licato '062 in view of Dumoulin '081 and in further view of Nishimura '424 is respectfully traversed.

As previously noted, an essential novelty of applicant's invention resides in the fact that magnetic gradient flow pulses are generated in the same spatial direction as that of a phase-encoding gradient field pulse. It is respectfully noted that the Examiner has failed to even comment upon this feature of all applicant's claims. That is, the Examiner's discussion of the various cited references is entirely silent with respect to the claim requirements that flow pulses for dephasing or rephasing magnetic resonance spin of a blood flow within a subject must be generated in the same direction as the phase-encoding gradient magnetic field (e.g., see the last three lines of claim 1 and the fourth integer/paragraph in the body of independent claim 9). Independent claims 1 and 9 have been amended above so as to make this stark and important and patentable distinction over all the cited prior art even more prominently noticeable.

As previously explained in some detail, the primary Licato reference merely describes a general purpose MRI system configured so as to use nested gradient pulses –

in whatever MRI sequence might be desired (assuming that it can physically incorporate such nested gradient pulses). In particular, Licato teaches suppression of nerve stimulation by reducing sequence collection time. To reduce dB/dt, the gradient of the slice magnetic field and that of the readout magnetic field are changed. However, there is no such modification in the phase-encoding direction.

The Examiner relies upon Licato's Fig. 1 (which merely depicts the hardware of an exemplary MRI system), as well as col. 1, line 56 and col. 6, lines 43-59. However, as will be seen from the below quotation of the entire two paragraphs thus referenced by the Examiner, Licato has nothing to do with teaching any particular direction for magnetic gradient flow pulses. At best, the paragraphs (which appear respectively in the "Background of Invention" section and in reference to Fig. 2 which also describes only a background, "conventional" gradient sequence) teach only conventional, generic MRI systems features which the applicant has never herein claimed to have invented. Instead, the applicant here claims to have invented method and apparatus for achieving improved magnetic resonance angiography (MRA) by causing magnetic gradient flow pulses to be spatially oriented in the same spatial direction as phase-encoding magnetic gradient field pulses. Neither Licato, Dumoulin nor Nishimura have any teaching that is even slightly suggestive of this novel feature of the applicant's claimed invention.

To demonstrate the irrelevance of the cited portions of Licato, the entire paragraphs of text cited by the Examiner are quoted below:

> "In many circumstances, the only factor of importance in the generation of a gradient field pulse is the integral of gradient amplitude over the duration of the gradient pulse (i.e. the gradient pulse area). This is true, for example, with slice-select refocusing, phase-encoding, velocity or flow compensation, spoiling, rewinding and readout defocusing gradient pulses. Since the shortest duration gradient pulse of a given area provides the greatest flexibility in selecting pulse sequence echo time (TE) and pulse sequence repetition time (TR), it is highly desirable for the MRI system to produce these gradient pulses with the minimum pulse duration possible given the prescribed pulse area." [1:52-63.]
>
> * * *
>
> "Referring to FIG. 2, a graphic representation of an [sic] exemplary gradient sequences are depicted. The gradient magnetic field sequences denoted (G_{SLICE}, G_{PHASE}, and $G_{READOUT}$) which have the same direction as the polarizing field B_o, but which have a gradient along the respective z, y and x axes. It will be appreciated, that G_{SLICE}, $G_{READOUT}$ and G_{PHASE} may be applied on any physical gradient axes G_x, G_y, G_z, or any linear combination thereof, depending on the selected orientation for the slice. The slice select pulse sequence G_{SLICE} 20 includes, but is not limited to, a slice select pulse 22, a rephaser pulse 24, and a killer or dephaser pulse 26. The phase encoding pulse sequence, G_{PHASE} 30 includes, but is not limited to, the phase encoding pulse(s) 32 and phase rewinder pulses(s) 34. Lastly, the readout pulse sequence, $G_{READOUT}$ 40 includes, but is not limited to, a prephaser pulse 42, a readout pulse 44, and a killer or dephaser pulse 46." [6:43-59.]

The first-quoted paragraph merely mentions a catalog of different types of known gradient field pulses. The second-quoted paragraph merely notes that the conventional choice of orthogonal x, y, z axes coinciding with readout, phase-encoding and slice-selection magnetic gradient pulses is an arbitrary designation. However, as the Examiner will appreciate, in whatever sequence designated (or skewed in space), the readout, phase-encoding and slice-selection gradient fields are orthogonally related to each other and serve respectively different functions.

The Examiner has quoted or paraphrased some of this language and apparently relies upon the possibility that one skilled in the art could program this general purpose MRI system to practice the applicant's invention. Even assuming that such could be done, it would have to be done with hindsight because there is no suggestion here that any flow pulse should be in the same direction as the phase-encoding pulse. The resources available to humans on this earth have not materially changed for millions of years and, therefore, it would have been possible for people long ago to do everything that we do today. However, such was not obvious to those persons of long ago.

Neither was applicant's claimed invention obvious to Licato – or any others skilled in the art prior to applicant's invention. That is, there is no logical suggestion of any kind in the prior art (including Licato in its entirety) that could have led those of only ordinary skill in the art to applicant's recognition that there is an advantage in orienting

magnetic gradient flow pulses in the same direction as magnetic gradient phase-encoding pulses.

The Examiner admits that Licato does not describe subtraction imaging. For this admitted deficiency, the Examiner relies upon Dumoulin which does deal with methods for angiography. However, the applicant is not claiming to have invented angiography or subtraction imaging *per se*. Instead, the applicant is claiming to have invented an improved angiography method/apparatus which, *inter alia*, utilizes magnetic gradient flow pulses spatially oriented in the same direction as the magnetic gradient field used for phase-encoding in an MRI sequence.

Dumoulin discloses a technique of applying, to both SE and FE types, a phase contrast method in which a flow-encoding pulse is applied in the slicing direction and in a one-way direction opposite to the application direction of first and second pulses, thereby rendering differences in motion. In contrast, in the present invention, the flow-encoding pulse is applied in the PE direction (or in the PE and RO directions). Further, in Dumoulin, a two-dimensional projection image is obtained, whereas in the present invention, a three-dimensional image is obtained.

Indeed, the sequence depicted at Fig. 2 of Dumoulin explicitly shows flow-encoding magnetic gradient pulses 28, 30 to be imposed in the same spatial direction as G_z, the slice-selection gradient. In particular, there is no teaching of any flow-encoding

pulses oriented in the same direction as G_Y which is the phase-encoding magnetic gradient field depicted in Fig. 2 of Dumoulin.

Accordingly, to the extent that it has relevance, Dumoulin teaches away from the applicant's claimed invention.

The Examiner also admits that even the combination of Licato and Dumoulin still does not provide for timing acquisition of images during systolic and diastolic periods of heartbeat. For this admitted further deficiency, the Examiner relies upon Nishimura. Of course, the applicant has never here claimed to have invented NMR angiography using subtraction of systolic and diastolic images *per se*. Once again, applicant has invented an improved adaptation of such prior art approaches by causing the spatial orientation of flow pulses to coincide with that of magnetic gradient field phase-encoding pulses. Nishimura does not offer any such teaching or suggestion.

Indeed, Nishimura is similar to Dumoulin in its teaching. However, to render differences in motion, pulses are applied in both the slicing direction and RO (readout) direction.

Some of the rationale underlying advantages of applicant's discovery is given in connection with Figs. 6-8 and described at pages 13-15 of the applicant's specification. For reasons therein explained, the applicant has discovered that improvements in MRA

can be had if flow pulses are oriented in the same direction as phase-encoding pulses. This is a novel and non-obvious insight that does not appear to be addressed by any of the three cited references.

Given such fundamental deficiencies of all three references with respect to the above-discussed features of independent claims 1 and 9, it is not believed necessary at this time to discuss additional deficiencies of this allegedly "obvious" combination of references with respect to other features of the rejected claims.

The rejection of claims 15-20 under 35 U.S.C. §103 as allegedly being made "obvious" based on Licato/Dumoulin/Nishimura in further view of Miyazaki '376 is also respectfully traversed.

Fundamental deficiencies of Licato/Dumoulin/Nishimura discussed above also apply to applicant's independent claims 15 and 20. Among other things, both of these independent claims also require that the magnetic gradient flow pulses be generated to produce a gradient in the same direction as the phase-encoding gradient magnetic field. None of the first three references offer any such teaching or suggestion – and neither does Miyazaki. Indeed, as already noted at pages 10-11 and 14 of applicant's response filed February 6, 2008, to the extent that Miyazaki has relevance, it also teaches away from the applicant's claimed invention (e.g., it teaches the use of magnetic gradient flow pulses oriented in the readout (i.e., frequency encoding) magnetic gradient direction).

In short, even if all features of all four references are somehow miraculously "combined" *arguendo*, one still fails to find any teaching or suggestion of the applicant's claimed invention.

Accordingly, this application is now believed to be in allowable condition, and a formal notice to that effect is respectfully solicited.

Respectfully submitted,

NIXON & VANDERHYE P.C.

By: Larry S. Nixon

Larry S. Nixon
Reg. No. 25,640

LSN:lef

901 North Glebe Road, 11th Floor
Arlington, VA 22203-1808
Telephone: (703) 816-4000
Facsimile: (703) 816-4100